# *"The Effect of Exchange Rate Volatility on Trade Flows Between the US and Countries of the Far East"*

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**Abstract**

*This paper examines the impact of exchange rate volatility on international trade flow using a traditional gravity model. The study uses quarterly panel data from 1994 to 2007 and incorporates trade flow between the United States and six East Asian countries. Standard deviations of the percentage change of the bilateral exchange rate are used in defining exchange rate volatility. After accounting for fixed effects, and with country-specific autocorrelation through the Parks Method, exchange rate volatility is found to have an insignificant effect on total trade between the US and countries of the Far East.*

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## 1. Introduction

International trade benefits countries through the principle of comparative advantage, allowing nations to utilize gains from trade. The development of East Asian economies over the past decade is an excellent example of this principle. In 2006 the average trade percentage of Gross Domestic Product (GDP) for countries of the Far East was 9.7 percent.[1] However, simply by examining the ratio of exports-to-GDP for Far East countries, this average was 95.7 percent. Additionally, East Asian production has grown from 9 percent to 14 percent of world GDP from 1996 to 2006[2] ("Asian Development Outlook," 2007). While the United States is the largest domestic economy in the world, international trade remains an important part of economy. The World Trade Organization found that the international trade to GDP ratio was 5.1 percent in 2007 for the United States. Additionally, according to the Foreign Trade Statistics at the US Census Bureau, international trade between the US and Far East countries has increased by 129 percent from 1998 to 2008[3].

When examining currencies throughout the world, it is known that the United States has a "free floating" exchange rate policy in regards to foreign currencies. For example, the dollar consistently fluctuates and floats freely against the euro, British pound, and Japanese yen. This exchange rate policy, however, is not common amongst East Asian (EA) countries. Only two of the nine EA countries exercise a "free floating" exchange rate.[4] The other seven either enforce a complete peg to the US dollar, or a "managed float," indicating that the government or central bank reserves the right to intervene in the foreign exchange rate should the exchange rate begin

[1] Far East countries include Singapore, Malaysia, Indonesia, Thailand, Philippines, China, Hong Kong, Taiwan, and [South] Korea (Wilson and Ren, 2008). These countries will be used throughout the study.
[2] Published by 2008 World Development Indicators.
[3] By looking at the Far East countries while excluding China, international trade with the US has increased by 39% from 1998 to 2008.
[4] The Philippines and South Korea

to rise or fall beyond a designated bound. These policies have been established by the Far East countries in order to maintain steady trade levels with the US.

While the exchange rate policies enforced by the EA member nations are open for debate, many legal steps have been taken in an attempt to put pressure on Far East governments to re-examine their intervention in the foreign exchange market in order to influence the price of their domestic currency. The International Monetary Fund has addressed this issue in Article IV, Section 1(iii) of the *Articles of Agreement* by declaring that "each member [of the IMF] shall avoid manipulating exchange rates or the international monetary system in order to prevent effective balance of payments adjustment or to gain an unfair competitive advantage over other members" (Martin, 2008).[5] The United States legislature has been active in addressing the East Asian exchange rate policies as well. The 110th Congress, which concluded at the end of President George W. Bush's second term, had proposed several bills of legislation in order to increase pressure on EA countries to remove their currency manipulation policies. Bills include the Currency Harmonization Initiation Through Neutralizing Action Act of 2005[6], the Fair Currency Act of 2007[7], the Japan Currency Manipulation Act[8], and the Currency Reform and Financial Markets Access Act of 2007[9] (Martin, 2008).

The primary reasoning behind the reluctance of EA countries switching to a "free floating" exchange rate can be attributed to the fear that the decrease in government intervention, and a "free floating" exchange rate policy will ultimately lead to higher exchange rate volatility against the US dollar. It has been debated that an increase in exchange rate volatility will consequently result in less international trade. The Far East had experienced a period of

[5] The IMF has not found any of the East Asian countries in violation of this rule as of 2008.
[6] H.R. 321
[7] H.R. 782 and S. 796
[8] H.R. 2886 and S. 1021
[9] S. 1677

particularly high exchange rate volatility in the late 1990s, which affected US international trade with countries in East Asia during that period. Specifically, increased exchange rate volatility was seen during the Asian Financial Crisis in 1997, which began with the fall of the Thai baht.

Originally pegged to the US Dollar by the Thai government, the baht was floated in July 1997, and the currency immediately depreciated against the US dollar. By October, the Thai baht decreased 55 percent in value compared to the US dollar in January 1997. Other countries near Thailand in the Far East also experienced similar devaluations in their currencies – the Indonesian rupiah fell by 54 percent, the Malaysia ringgit by 34 percent, and the Filipino peso by 33 percent (Choudhry, 2005). International trade of East Asian countries between 1997 and 1998 reversed the general upward trend of increased bilateral trade over time. The US Department of Commerce reported a net decrease in total yearly exports from 1997 to 1998 in Thailand, Malaysia, Singapore, Indonesia, the Philippines, Hong Kong, and Taiwan.

Because EA nations have experienced the negative effects of a free-floating exchange rate with the US dollar with the Asian Financial Crisis, these countries are hesitant to remove their current policies that have maintained currency stabilization. This notion is attributed to the uncertainty of the consequences related to increased exchange rate movements. However, while the progression to a floating exchange rate policy will lead to greater fluctuation in the exchange rate of their domestic currencies relative to the US dollar, it cannot be determined that this policy decision will ultimately lead to less trade with the US. This goal of this study is to determine the impact of exchange rate volatility on bilateral trade flows between the United States and countries of the Far East.

## 2. Survey of the Literature

Many studies have linked exchange rate volatility to trade flows amongst nations, with differing conclusions. Dell'Ariccia (1999) finds that there exists a significant negative effect of bilateral exchange rate uncertainty on international trade amongst economies of the European Union. This negative association is due to increased risk, which leads risk-averse agents to reduce their foreign trade activity. The study suggests many different ways to define exchange rate volatility, including the standard deviation of the percentage change of the bilateral exchange rate. The model uses panel data from 15 EU countries from 1975 to 1994 through a traditional gravity equation. Dell'Arriccia's (1999) model analyzes the amount of bilateral trade between nations in relation to Gross Domestic Product, distance between the two economies, and an assortment of other variables that should influence the amount of trade between countries. In the original study, country-specific fixed effects are used in order to analyze bilateral trade, but Dell'Ariccia (1999) indicates that this method would be biased because central banks would try to prevent exchange rate volatility within markets. Therefore, the study examines the effect of Central Bank interaction upon exchange rate volatility. Results show that total elimination of exchange rate volatility in 1994 would have determined a 12 percent increase in trade. Dell'Ariccia (1999) also finds that using the nominal bilateral and real bilateral exchange rate is nearly interchangeable.

Bahmani-Oskooee and Kovyryalova (2008) also examine bilateral exchange rate volatility and trade flows, but strictly focus on the United States and United Kingdom. The time-series study analyzes the dollar-pound exchange rate volatility against trade flows between the US and UK. In the paper Bahmani-Oskooee and Kovyryalova (2008) examine the effect of the amount of trade between the US and UK relating to 177 commodities. Because the analysis is

focused on trade between 1971 and 2003, a standard autoregressive distributed lag (ARDL) model is used. Akaike's Information Criterion (AIC) was used in determining that four lags on each variable would be the optimum number of lags. They found a significant negative effect of the volatility in the pound-dollar exchange rate on the amount of trade between the US and UK. In addition, Bahmani-Oskooee and Koyryalova (2008) find that the exchange rate volatility has a stronger effect on exports and imports in the short-run over the long-run.

Another means of measuring volatility is to take the difference between maximum and minimum bilateral exchange rates. Cho et al. (2002) uses extreme differences in exchange rates in his model looking at agricultural trade flows. Cho et al. (2002) uses panel data from ten developing countries, and looks at the agriculture industry compared to the machinery, chemical, and manufacturing sectors. While exchange rate volatility is found to be a statistically significant factor of agricultural trade flows, the coefficient is small. Cho et al. (2002) found that compared to other sectors of the economy, the amount of trade in the agriculture industry is more negatively affected by exchange rate volatility. This study proves that certain sectors behave differently in relation to exchange rate volatility, and concludes that the negative effect of exchange rate volatility is not equal across all sectors of an economy.

While some of the research suggests that there exists a significant negative relationship between exchange rate volatility and trade flows, there exists other research that suggests there is no effect of exchange rate volatility on trade flows. Kurihara (2003) found that the gain in trade flow after eliminating nominal exchange rate variability through a currency union is less than 1 percent, suggesting the negative effect of exchange rate volatility can be contained by the investor's ability to hedge through currency futures, swaps, or options. The author uses a double-log gravity model to analyze the effect of the Asian-Pacific Economic Cooperation

(APEC), with real bilateral exchange rates as the base for the equation. However, the real exchange rate was not found to be statistically significant.

In addition, Côté (1994) concludes in a paper released by the Bank of Canada that an increase in volatility of exchange rates is ambiguous to the level of trade between two countries. This is due to many different factors relating a firm's production to its decisions to trade in the international arena. Côté (1994) gives many reasons for her findings on the insignificant effect of ERV, including the ability for businesses to apply hedging techniques to minimize exchange rate risk. There has been a dynamic shift in the international investment market. Over the past decade, the ability for firms to hedge against exchange rate risk allows more trade to occur in a period of time with the same given factor of volatility. This overall conclusion is also in line with Tenreyro (2004), where the research indicates that exchange rate volatility has no effect on trade after accounting for instrumental variables. Tenreyro (2004) examines nominal exchange rate variability for country pairs for 104 nations from 1970 to 1999.

Clark et al. (2004) also finds that there is no relationship of exchange rate fluctuations on trade over the last two decades. This can be partially attributed to the increase of ease of capital flows across countries in recent years. Clark et al. (2004) also clarifies the augmentation of financial hedging techniques as a means to reduce the risk associated with exchange rate volatility. The study examines all International Monetary Fund countries who have released data that is available from 1980 to 2000. While it is determined that there does exist a negative effect of exchange rate volatility on trade flows, the relationship is not robust enough in order to conclude that there is an effect. When Clark et al. (2004) uses country-pair specific fixed effects, their analysis reveals no negative association between volatility and trade.

While no study has looked specifically at the effect of exchange rate volatility on trade between US and East Asian countries, a few studies have analyzed the volatility of exchange rates before and after the 1997 financial crisis. For example, Baharumshah and Wooi (2007) found that bilateral exchange rates became more volatile after the 1997 crisis in comparison to prior years. Using the Exponential General Autoregressive Conditional Heteroskedasticity model (EGARCH), the authors conclude that while only three of the Far East currencies were considered volatile before 1997, all were considered volatile after the crisis. While studies have not proven the cause of increased volatility, some believe it can be attributed to Far East countries' heavy dependence on exports and on foreign capital for the development of their emerging economies.

Finally, there are multiple ways of defining a country's exchange rate. Wilson and Ren (2008) similarly examine the periods before and after the Asian financial crisis of 1997. The study examines Nominal Effective Exchange Rate (NEER) volatility of 9 Far East countries from 1994 to 2003. The effective exchange rate, also known as the multilateral exchange rate, measures a country's currency relative to all other currencies with whom they trade. While examining the countries, Wilson and Ren (2008) conclude that Asian economies were experiencing dissimilar economic conditions during the time of the financial crisis. For example, while South Korea's economy was much more stable and competitive with the Japanese, poorer countries were much more concerned with relative currency fluctuations. The results of this paper suggest that a unilateral basket peg rate would minimize exchange rate volatility. They conclude through a GARCH approach that the mean exchange rate volatility was significantly greater after the Asian crisis than before. The average exchange rate volatility doubled when examining the NEER, and quadrupled when looking at bilateral exchange rates against the US

Dollar. Their results suggest that the pegged exchange rate would decrease exchange rate volatility in countries affected by the Asian crisis. The pegged rate to the US Dollar, in comparison to a floating rate, provides stability in the foreign economies. Their findings prove that the monthly NEER values of countries in East Asia were much more aligned prior to 1997.

## 3. Research Design

This study will apply a traditional gravity model to analyze the effect of exchange rate volatility on trade flows between the US and Far East. Countries included in the study are Thailand, Malaysia, Indonesia, the Philippines, South Korea, and Hong Kong. The theory states that the volume of trade between two countries is a factor of the size of the economies of the two trading countries and the distance between the two trading countries. Dell'Ariccia (1999) utilizes the standard gravity model in his work to examine inter-EU trade, but uses a double-log model to estimate the dependent variable. The variables for trade, GDP per capita, and distance have all been logged to better account for the nonlinear relationship between the independent and dependent variables. The study also incorporates time into models to examine the change in exchange rate volatility over quarter periods. The pooled Ordinary Least Squares (OLS) regression for panel data from 1994 to 2007 is:

$$\begin{aligned}\text{Log}(Trade_{ijt}) = {} & \beta_0 + \beta_1 \log(GDPCap_{it} * GDPCap_{jt}) + \beta_2 \log(Distance_{ij}) + \beta_3(ERV_{jt}) \\ & + \beta_4(ASEAN_j) + \beta_5(Lang) + \beta_6(PegUSD) + \beta_7(Time\ Dummies) \\ & + \beta_8(Country\ Dummies) + u_{ijt}\end{aligned} \quad (1)$$

Where subscript *i* represents the US, *Trade* indicates the sum of imports and exports between the US and East Asian country *j* in period *t*, and *GDPCap* represents the total size of gross domestic

product divided by the country's population. Total trade flow between countries is expected to increase as the product of the countries' GDP per capita increases, and decrease when the distance between economies increases. As the economies of two countries expand, bilateral trade tends to increase as well. Hence $\beta_1$ is expected to be positive. The variable *Distance* is calculated "as the crow flies," meaning the shortest possible distance between the two countries (Frankel, 1997). As the distance between countries increases, the trade between them tends to decrease, possibly from more expensive shipping costs. Therefore, the expected sign of $\beta_2$ is negative. All variables, as well as a description of the variable with the expected sign, can be found in Table 1 of the Appendix.

This research builds upon the traditional gravity model by including the exchange rate volatility (ERV). Because agents tend to be more-risk adverse (Dell'Ariccia, 1999), an increase in exchange rate volatility should negatively affect the amount of trade between two countries. ERV will be calculated by using the bilateral nominal exchange rate. The variable ERV for all regressions in this study is measured as the standard deviation of the daily percentage change of the bilateral exchange rate. The coefficient for ERV should be negative. This study builds upon the existing literature by examining the ERV on a quarterly basis. The measure for volatility is more accurate during quarterly intervals rather than annually. Volatility is much easier to capture over a quarter because of the shortened time period to account for movements in the exchange rate. Because quarterly data was collected for this paper, volatility is measured as the standard deviation of the daily percentage change of nominal exchange rates for three months.

Other variables included in the model are common language and regional trade agreement status. Dell'Ariccia (1999) explains in his model the importance of common language between trading nations. Common language between two nations should, ceteris

paribus, have a positive relationship with the volume of trade. Trade volume is expected to be larger between the US and East Asian nations that have English as one of their official secondary languages. The dummy *Language* should positively affect international trade. One would expect countries that do not have a language barrier to increase the amount of trade. Of the East Asian countries in this study, the governments of Malaysia, Singapore, the Philippines, and Hong Kong have declared English as a second language in their country. Since the governments have declared English as an official secondary language, it would be expected that these countries would have a greater English-speaking population. Therefore, these East Asian nations should be able to conduct more international trade with the United States because there is less of a language barrier amongst traders.

Regional trade agreement status also can be a significant factor on the amount of trade between countries. The dummy *ASEAN* denotes countries that are included in the Association of Southeast Asian Nations. These countries consist of Thailand, Malaysia, Indonesia, the Philippines, and Singapore. Because the ASEAN countries have smaller, less stable economies, the coefficient for this variable should be negative (Wilson and Ren, 2008). Countries in the ASEAN should experience less trade with the United States than non-ASEAN counterparts. Also, the variable *PegUSD* is used as a dummy when countries have changed their foreign exchange rate policy in relation to the US dollar.

The current model suggests that the ERV of the current quarter is a factor of the amount of trade within that same quarter. This, however, might not be accurately capturing the total effect of ERV on trade. Economically speaking, it would be appropriate to incorporate the ERV at both time *t* and time *t-1*. In today's global market, firms have become much more agile and their ability to conduct business at a faster rate is evident given technology advancements. Due

to the increase of technology over the past 20 years, firms conducting business overseas within a quarter have the ability to receive payment for their products sold within a smaller time period than in previous years. Thus, ERV at time *t* should be included. Firms that can trade and receive payment within the same quarter should only be affected by the current quarter's ERV.

On the other hand, one of the major flaws with the first model deals with the time association between ERV and the amount of bilateral trade. Exporters are probably unlikely to instantly act upon increases in exchange rate volatility, but rather adopt a "wait and see" approach (Thorbecke, 2008). Not all firms can alter inputs fast enough to account for increased volatility in exchange rates (Clark, 2004). Firms looking to maintain risk aversion must incorporate exchange rate volatility into their ability to profit. From this ideology, there can be an argument made for the fact that large firms cannot conduct international business, distribute the product to the foreign country, and receive payment for the good instantaneously at the same exchange rate, nonetheless within the same quarter. Instead, firms producing for the international market must incorporate exchange rate risk, or the risk that exchange rates will fluctuate over time, into their business model. Therefore, in order to minimize the exchange rate risk, firms set up contracts at a given exchange rate in order to hedge against risk associated with volatility of the exchange rate. Contracts are created where the two players in the international market agree on a specific exchange rate, because payment is not collected until delivery occurs (Ozturk, 2006). For this reason, a lagged variable of ERV should be incorporated into the model in order to explain the amount of trade flow between two countries.

Model (2) accounts for this lapse in time. The ERV variable has been lagged by one period, and the contemporaneous variable has remained in the model. Table 4 shows the similar

regression using pooled OLS estimation, and includes both the lagged and contemporaneous variables.

$$\begin{aligned}\text{Log}(Trade_{ijt}) = {} & \beta_0 + \beta_1 \log(GDPCap_{it} * GDPCap_{jt}) + \beta_2 \log(Distance_{ij}) + \beta_3(ERV_{jt}) \\ & + \beta_4(ERV_{jt-1}) + \beta_5(ASEAN_j) + \beta_6(Language_j) + \beta_7(PegUSD) + \beta_8(Time) \\ & + \beta_9(Country\ Dummies) + u_{ijt}\end{aligned} \tag{2}$$

## 4. Data Analysis and Results

This study tests the effect of exchange rate volatility on trade flow between the US and East Asian countries. The quarterly data consists of 336 observations from six different Asian countries trading with the US, which consist of Thailand, Malaysia, Indonesia, the Philippines, South Korea, and Hong Kong. The countries of Taiwan, Singapore, and China were removed from the data set prior to any regression analysis due to insufficient data at the quarterly level. In this study, bilateral exchange rates were used in the model as reported from the Federal Reserve Bank of New York. The standard deviation of the daily percentage change of the bilateral exchange rate between the US and country *j* was used as the determinant of ERV. Total monthly exports and imports for the US to Far East countries can be found at the US Department of Commerce. Nominal GDP measures in quarterly intervals were taken from the World Bank and the International Monetary Fund's *International Financial Statistics* database.

Quarterly results from 1994 to 2007 have been reported for the six countries. Table 2 shows the descriptive statistics for the variables used in the following regressions. The average ERV, which is measured as a percentage, was 1.647, with a range from 0 to 56.608. The standard deviation for the ERV variable was 4.276. As found in the descriptive statistics, three

of the six countries have English as a government recognized official second language and four of the six countries are in the regional trade agreement ASEAN.

The results for pooled OLS regression without the lagged variable can be found in Table 3. These results correlate to equation (1) in the study. The adjusted $R^2$ value for the pooled OLS regression is 0.8638, indicating that over 86 percent of the variance of the data can be defined by the regression. Variables measuring GDP per capita and distance are statistically significant at the 1 percent level, and their corresponding signs are correct as predicted. From this equation, a 1 percent increase in the product of GDP per capita increases trade flow amongst countries by 0.66 percent. The distance variable was significant and negative, in line with expectation and theory behind the gravity model. Year is correctly predicted as positive and statistically significant at the 1 percent level. The coefficient of the ERV variable is significant; however, with the pooled OLS results the corresponding sign is contrary to what was predicted.

Next, equation (2) was examined, in order to incorporate the lag of the ERV variable by one period. The data set consists of 330 observations, with six incomplete due to the lack of data for the first quarter of 1993. The equation has an overall adjusted $R^2$ value of 0.8682, and does a better job of explaining the overall variance in the data in relation to equation (1). Therefore, equation (2) is used throughout the rest of the study. From the pooled OLS regression, all variables that were previously statistically significant remain significant with the exception of Year. Table 4 displays the coefficients, standard errors, and t-values of equation (2).

Because the data is panel, unobserved heterogeneity could exist, indicating that the exchange rate volatility affects bilateral trade differently depending on the country studied. In order to test for unobserved heterogeneity, countries need to be examined separately. The model uses fixed effects in order to correct for unobserved heterogeneity. Table 5 displays the

regression while using one way fixed effects by country. The F-test value of 82.05 indicates that the intercepts of the equations differ by country. All time invariant variables have been dropped from the equation while using fixed effects by country.

The one-way fixed effects by country show that the impact of ERV on bilateral trade flow is country-specific. The F-test confirms that the intercept of the equation for each country is different, and country-specific dummies must be created and incorporated into future models. In addition, autocorrelation should also be examined to see if the error terms are related over time. Table 6 shows the first order autoregressive estimates by country. With a panel data set that incorporates country-specific autoregression, the Parks Method should be used in order to create an unbiased model.[10]

The Parks Method integrates first order autocorrelation by cross section within the panel data set. Table 7 displays the regression while using the Parks Method to account for country-specific autocorrelation. Country dummies have been maintained in order to include fixed effects. From the model, the lagged ERV variable is negative, although insignificant, in its effect on bilateral trade. The sign of the coefficient, while technically insignificant, is in line with economic reasoning by concluding that volatility of exchange rate in the previous quarter affects the actions of firms looking to partake in international trade at the current time. However, because the coefficient is insignificant, there is no effect on trade. Additionally, the contemporaneous variable for ERV is insignificant as well, but the coefficient is positive. The positive sign for the coefficient, which is still insignificant, is contradictory as to what is expected. There has been little research done that has concluded a positive effect of ERV on bilateral trade flow. In one study, De Grauwe (1988) concludes that the reasoning behind the

[10] It should be noted that Parks Method estimation can only incorporate a first-order autoregression into the model. The Parks Method also demands that there exist an equal number of observations for each cross sectional effect.

positive relationship is due to the "dominance of income effects over substitution effects." With a given increase of ERV, the expected marginal utility of export revenue increases, and this, in result, tempts firms to increase the amount of exports during highly volatility exchange rate periods.

The variable measuring GDP per capita is significant at the 5 percent level, and the variable Year is significant 1 percent level. Both of these variables are correctly predicted as positive. With the final regression, an increase in 1 percent of the product of GDP per capita increases the total trade between the two countries by 0.11 percent. The dummy variable capturing the pegged exchange rate with the dollar is positive but insignificant. All time invariant variables must be discarded in the regression. When examining more than one lag in the equation, the results remain unchanged, and in order to conserve observations, only one lag of the variable measuring ERV was incorporated into the model. Exchange rate volatility is still insignificant to level of trade.

## 5. Conclusion and Continuing Research

This study aims to examine the effect of exchange rate volatility on trade flow between the US and countries of the Far East. Six East Asian countries and quarterly time periods from 1994 to 2007 were used to comprise the panel data set. Exchange rate volatility is measured by the standard deviation of the daily percentage changes of the bilateral exchange rate. The original model examines exchange rate volatility and trade flow within the same quarter. After lagging the volatility variable one period and keeping the contemporaneous variable in the model, the exchange rate volatility is found to be statistically insignificant when accepting country-specific autocorrelation and overall heteroskedasticity. There is no effect of ERV on bilateral trade flows

between the US and East Asian countries. Individual country dummies were created following the one-way fixed effects regression in order to create a better fitting model of the data. The findings of this study imply that, because ERV has no significant effect of trade, there should not be a major policy concern regarding a country's currency in relation to its trade with the US. The consensus in the literature is that floating exchange rates lead to greater volatility. However, this study concludes that an increase in volatility has no impact on the flow of trade between East Asian countries and the US. Therefore, EA countries do not need to be overly concerned about the removal of their currency manipulation policies.

The limitations of the paper include the lack of variables used in the final regression. The autoregressive nature of the Parks Method estimation eliminates all time-invariant variables. Parks Method also must eliminate the first quarter of the data. Secondly, while the data is gathered quarterly, true exchange rate volatility could be measured on a daily, if not hourly, basis. Defining exchange rate volatility as a monthly percentage change eliminates all of the instantaneous fluctuation of the exchange rate within any given month. Thirdly, while all variables in the data set are reported in quarterly increments, the population data is not. Population figures are only reported on an annual basis, and therefore, the variability over quarters, while probably not substantial, has not been documented in the study. In addition, the lack of observations for China, Singapore, and Taiwan suppresses the data set by only collecting two-thirds of the observations from countries that are considered members of the Far East (Wilson and Ren, 2008). Also, the addition of the lagged variable causes econometric issues. While the contemporaneous and lagged variables are correlated, theoretically it is shown in previous literature that both variables should be incorporated into a model to determine trade flows.

Further research should examine the impact of central bank intervention with respect to exchange rate volatility and trade flow. The addition of a central bank intervention variable could explain some of the simultaneous bias within the model. Dell'Ariccia (1999) and Cho et al. (2002) account for simultaneity bias by creating a model that incorporates governmental attempts to stabilize exports and imports flow. Past studies have proven that exchange rate volatility negatively affects a country's international trade, and therefore central bank involvement for the stabilization of their currency leads to bias within the model. Central bank stabilization efforts would lead to a negative relationship within the data between exchange rate volatility and trade, but this negative effect would not represent the causality of increased exchange rate volatility on trade (Dell'Ariccia, 1999). This paper examines a time period in the East Asian countries where government or central bank currency intervention is prominent. According to the International Monetary Fund, China, Hong Kong, and Malaysia all had fixed currencies to either the US dollar or Japanese yen at some point between 1990 and 2004, and Malaysia and Thailand have had currency arrangements fixed to a composite for some time during the same period (Wilson and Ren, 2008). The more the government intervenes with the stabilization of their currency, the less volatile their exchange rates should be, and therefore there should be an increase in trade between the US and the foreign country. Additionally, further research on this topic should examine the immediate effects of the Asian crisis in 1997. Within the data set, a structural break studying pre- and post-Asian Crisis responses to the impact of ERV on international trade with the US.

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## 7. Appendix

### Table 1 – Summary of Variables

| Variable | Description | Expected Sign |
|---|---|---|
| Trade | Sum of imports and exports between the US and East Asian (EA) country | n/a |
| GDPCap | Product of GDP per Population of the US and EA country | Positive |
| Distance | Distance between the US and EA country "as the crow flies" | Negative |
| ERV | Exchange rate volatility – measured as the standard deviation of the percentage change of the bilateral exchange rate | Negative |
| LagERV | 1 period lag of *ERV* | Negative |
| ASEAN | Dummy representing Association of Southeast Asian Nations (1 = Yes) | Negative |
| Language | Dummy representing if EA country has English as a 2nd language (1 = Yes) | Positive |
| PegUSD | Dummy representing if EA currency has altered current pegging status relative to the dollar during the quarter (1 = Yes) | Positive |
| Year | Year | Positive |
| Q1 | Dummy representing quarter 1 | n/a |
| Q2 | Dummy representing quarter 2 | n/a |
| Q3 | Dummy representing quarter 3 | n/a |

### Table 2 – Descriptive Statistics

| Variable | N | Mean | Std Dev | Minimum | Maximum |
|---|---|---|---|---|---|
| Log (Trade) | 336 | 8.714 | 0.527 | 7.688 | 9.961 |
| Log (GDP Per Capita) | 336 | 17.452 | 1.352 | 15.050 | 19.895 |
| Log (Distance) | 336 | 8.903 | 0.149 | 8.633 | 9.069 |
| ERV | 336 | 1.647 | 4.276 | 0 | 56.608 |
| ASEAN | 336 | 0.667 | 0.472 | 0 | 1 |
| Language | 336 | 0.5 | 0.501 | 0 | 1 |
| PegUSD | 336 | 0.015 | 0.121 | 0 | 1 |
| Year | 336 | 2000.5 | 4.037 | 1994 | 2007 |
| Q1 | 336 | 0.25 | 0.434 | 0 | 1 |
| Q2 | 336 | 0.25 | 0.434 | 0 | 1 |
| Q3 | 336 | 0.25 | 0.434 | 0 | 1 |

**Table 3 – Pooled OLS Regression**

| Variable | Parameter Estimate | Standard Error | t Value[11] |
|---|---|---|---|
| Intercept | 5.2479 | 5.6724 | 0.93 |
| Log (GDP Per Capita) | 0.6556 | 0.0214 | 30.62*** |
| Log (Distance) | -2.4249 | 0.1230 | -19.71*** |
| ERV | 0.0156 | 0.0027 | 5.83*** |
| ASEAN | 1.6550 | 0.0726 | 22.81*** |
| Language | -0.1266 | 0.0221 | -5.73*** |
| PegUSD | -0.0117 | 0.0887 | -0.13 |
| Q1 | -0.0252 | 0.0302 | -0.84 |
| Q2 | -0.0089 | 0.0302 | -0.29 |
| Q3 | 0.0403 | 0.0300 | 1.34 |
| Year | 0.0063 | 0.0028 | 2.23** |
| | | | |
| | N = 336 | Adj $R^2$ = 0.8638 | |

**Table 4 – Pooled OLS using Lagged Variable**

| Variable | Parameter Estimate | Standard Error | t Value[11] |
|---|---|---|---|
| Intercept | 8.5970 | 5.6810 | 1.51 |
| Log (GDP Per Capita) | 0.6696 | 0.0216 | 31.07*** |
| Log (Distance) | -2.4660 | 0.1215 | -20.30*** |
| ERV | 0.0090 | 0.0032 | 2.84*** |
| LagERV | 0.0110 | 0.0032 | 3.43*** |
| ASEAN | 1.6999 | 0.0725 | 23.43*** |
| Language | -0.1207 | 0.0219 | -5.51*** |
| PegUSD | 0.0046 | 0.0972 | 0.05 |
| Q1 | -0.0097 | 0.0302 | -0.32 |
| Q2 | -0.0147 | 0.0296 | -0.50 |
| Q3 | 0.0424 | 0.0294 | 1.44 |
| Year | 0.0046 | 0.0028 | 1.65 |
| | | | |
| | N = 330 | Adj $R^2$ = 0.8682 | |

[11] Asterisks are used on the t-value to code the significance of the coefficient at the 10% (1 asterisk), 5% (2), or 1% (3) level.

**Table 5 – Fixed Effects by Country**

| Variable | Parameter Estimate | Standard Error | t Value[11] |
|---|---|---|---|
| CS 1 – Thailand[12] | 0.4573 | 0.0986 | 4.64*** |
| CS 2 – Malaysia | 0.7505 | 0.0760 | 9.88*** |
| CS 3 – Indonesia | 0.1587 | 0.1333 | 1.19 |
| CS 4 – Philippines | 0.4193 | 0.1341 | 3.13*** |
| CS 5 – South Korea | 0.8697 | 0.0244 | 35.66*** |
| Intercept | -42.9373 | 4.6589 | -9.22*** |
| Log (GDP Per Capita) | 0.2513 | 0.0423 | 5.93*** |
| Log (Distance) | 0 | . | . |
| ERV | 0.0041 | 0.0021 | 1.91* |
| LagERV | 0.0006 | 0.0023 | 0.28 |
| ASEAN | 0 | . | . |
| Language | 0 | . | . |
| PegUSD | 0.0195 | 0.0643 | 0.30 |
| Q1 | -0.0683 | 0.0208 | -3.29*** |
| Q2 | -0.0533 | 0.0199 | -2.67*** |
| Q3 | 0.0134 | 0.0196 | 0.68 |
| Year | 0.0234 | 0.0026 | 8.96*** |
| | | | |
| CS# = 6<br>TS#[13] = 55 | N = 330 | $R^2$ = 0.9446 | F = 82.05<br>(P < 0.0001) |

[12] CS 1 = Cross Section #1.
[13] TS# = Time Series.

**Table 6 – First-Order Autoregressive Estimates (ρ)**

| Country | Rho |
|---|---|
| Thailand | 0.6702 |
| Malaysia | 0.7561 |
| Indonesia | 0.6173 |
| Philippines | 0.9220 |
| South Korea | 0.7382 |
| Hong Kong | 0.8943 |

**Table 7 – Parks Method Estimation**

| Variable | Parameter Estimate | Standard Error | t Value[11] |
|---|---|---|---|
| CS 1 – Thailand | 0.1340 | 0.1388 | 0.97 |
| CS 2 – Malaysia | 0.4935 | 0.1147 | 4.30*** |
| CS 3 – Indonesia | -0.2766 | 0.1778 | -1.56 |
| CS 4 – Philippines | -0.1008 | 0.2049 | -0.49 |
| CS 5 – South Korea | 0.8610 | 0.0805 | 10.70*** |
| Intercept | -67.2325 | 10.4103 | -6.46*** |
| Log (GDP Per Capita) | 0.1111 | 0.0529 | 2.10** |
| ERV | 0.0004 | 0.0012 | 0.31 |
| LagERV | -0.0017 | 0.0013 | -1.31 |
| PegUSD | 0.0256 | 0.0248 | 1.03 |
| Q1 | -0.1024 | 0.0133 | -7.69*** |
| Q2 | -0.0661 | 0.0129 | -5.11*** |
| Q3 | 0.0129 | 0.0106 | 1.22 |
| Year | 0.0369 | 0.0055 | 6.76*** |
| | | | |
| CS # = 6 | TS# = 55 | N = 330 | $R^2$ = 0.8705 |